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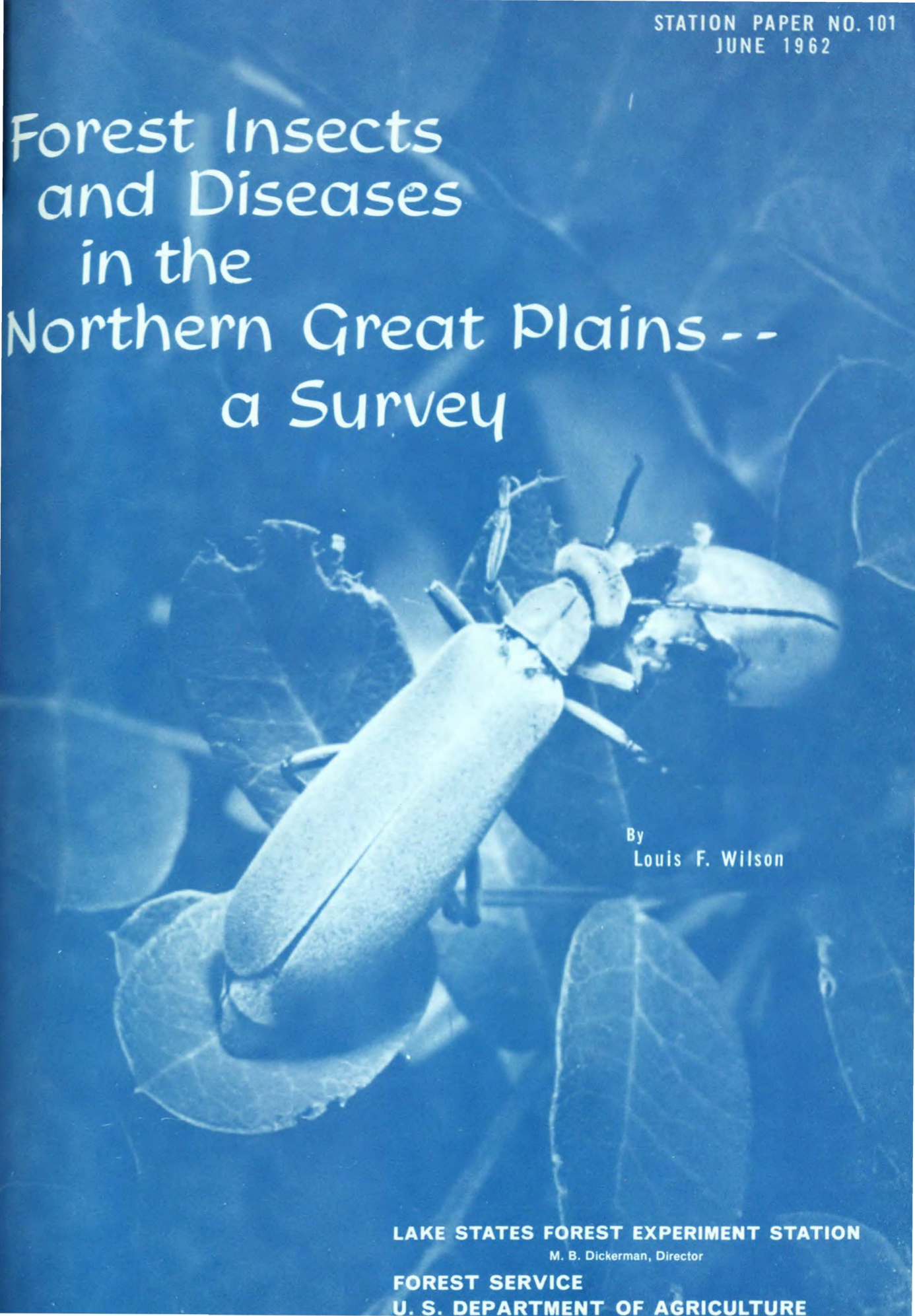
Forest Insects and Diseases in the Northern Great Plains -- a Survey



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FOREWORD

The Lake States Forest Experiment Station has a heritage of 30 years of research on shelterbelts in the Great Plains. The importance of shelterbelts has long been recognized — not from the standpoint of cellulose production, but because of their value in improving the harsh climatic and edaphic conditions characteristic of the area. Protection of the shelterbelts is thus of great concern. Considering the marginal growing conditions, even relatively light damage by insects and diseases may disrupt the function of a shelterbelt.

No previous studies have been made to determine the specific toll exacted by insects and diseases. To obtain necessary background information on this problem an extensive survey of shelterbelt pests in the Northern Great Plains was completed in 1960. This report presents the more significant findings of that survey.

Cover picture: The Caragana blister beetle, *Epicauta subglabra* (Fall), feeding on the seed pods and leaves of the Siberian peashrub. (F-500803)

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Forest Insects and Diseases in the Northern Great Plains — A Survey

by

Louis F. Wilson[1]

INTRODUCTION

The forest insect and disease problems of the Great Plains differ considerably from those of extensive forested areas. Native forests of the Northern Plains are limited largely to a few locations, mainly along water courses and a few upland areas where there is sufficient moisture. Extensive planting programs, undertaken primarily for establishing shelterbelts, alleviate in some degree this scarcity of trees and shrubs.

The most adaptable species have been selected for Plains plantings; nevertheless most of them do not fare as well as in their natural habitat. Those species that are outside their normal range are continually threatened by adverse environmental conditions. Lack of sufficient rainfall, severe winters, and adverse soil properties are but a few of the factors that prevent normal growth.

Under such conditions, trees are generally more vulnerable to attacks by insects and diseases. This is because: (1) fewer attacks are needed to seriously injure these already weakened trees, and (2) some pest species are able to establish themselves and develop more rapidly on trees of poor vigor. Furthermore, many shelterbelts are planted in single rows of one species. Therefore, if this one species is damaged or destroyed, the entire shelterbelt will lose its effectiveness.

The multi-rowed mixed species composition of some shelterbelts also poses problems in the proper timing of chemical control operations. Many different pest species may infest the same small area at different times during the growing season.

In spite of the potential destructiveness of insects and diseases in shelterbelts, little information is available on their actual status today. This paper reports the results of a survey made to observe and identify the species of insects and diseases in selected shelterbelts, nurseries, and natural stands in the Northern Great Plains. Also included are general comments on the potential importance of the various pests and on methods for their control, if known.

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[1] *Dr. Wilson is a forest entomologist on the staff of the Lake States Forest Experiment Station. The Station is maintained at St. Paul 1, Minn., by the Forest Service, U.S. Department of Agriculture, in cooperation with the University of Minnesota.*

FORESTED AND AFFORESTED AREAS

The predominant land use of the Northern Great Plains is the production of grass and crops. Only 1 percent of North Dakota and 3 percent of South Dakota contain trees, shrubs and brush. Natural stands are few and very localized. The Turtle, Killdeer and Pembina Mountains are the most extensive naturally forested areas in North Dakota. These are rolling hills covered with mixed hardwoods such as trembling aspen, balsam poplar, bur oak, green ash, paper birch, American elm and basswood. Except for the Black Hills in South Dakota, most of the remaining naturally wooded areas of the Northern Great Plains border lakes and rivers. The principal species along the waterways are cottonwood, elm, ash and boxelder. The Little Missouri drainage, in addition to these, also contains limber pine, ponderosa pine and Rocky Mountain juniper.

Afforestation has been the most important forestry activity in the Plains. Trees and shrubs are planted for shelterbelts primarily, but certain species are grown and harvested for fuel, fenceposts and lumber as well.

In North Dakota, tree planting began about 1870, and, following the Timber Culture Acts of 1873-74, several blocks of trees were set out for woodland purposes. These groves were scattered throughout the State. About 12 species of hardwoods and a few evergreens were planted, mostly around 1891 (fig. 1A).

Tree planting in South Dakota began about 1873, but most of the early plantings were established between 1885 and 1915, 95 percent of them east of the Missouri River.

In 1914 an experimental program of shelterbelt planting began at Mandan, N. Dak. By 1916 this had blossomed into a cooperative planting program south and westward to the plains of South Dakota, Montana and Wyoming (fig. 1B). These plantings continued until about 1933. These test plots aided greatly in determining the most favorable species for shelterbelt plantings.

In the early 1930's a severe drought stimulated the establishment of a shelterbelt zone. This task was called the Prairie States Forestry Project. Beginning in 1935 and ending in 1942, it was intended to cover about a 100-mile-wide belt along the eastern part of the Prairie States from North Dakota to Texas (fig. 1C). Because of its success, shelterbelts are still being planted, and several nurseries have been established to supply the necessary trees and shrubs.

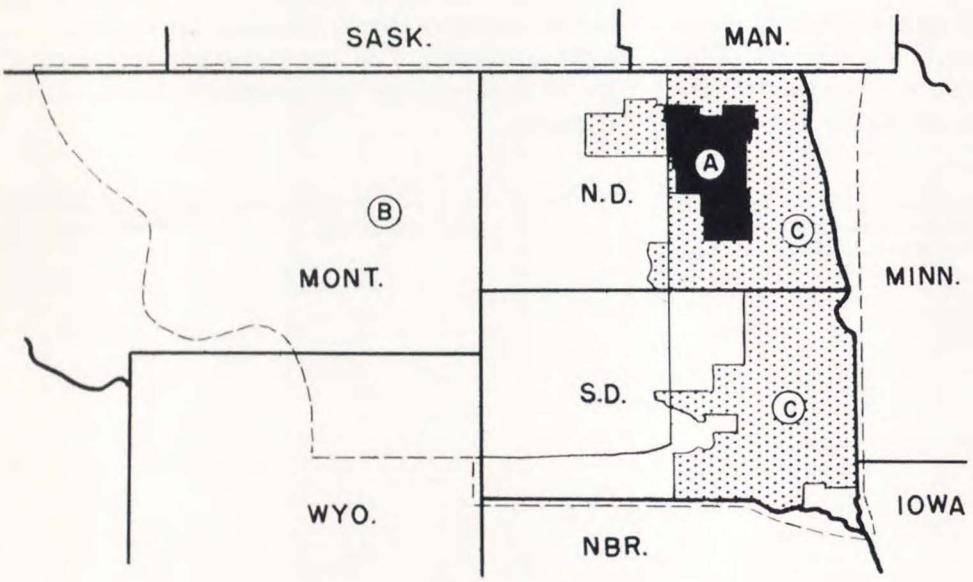

FIGURE 1. — Map of the Northern Great Plains showing major plantings since 1870. A, Old grove plantings 1870-1891 (location of survey block 1931) (Scholz 1935). B, Experimental and cooperative shelterbelt plantings begun 1916. C, Prairie States Forestry Project 1935-1942. The broken line shows the boundary of the Northern Great Plains in the United States.

SAMPLING

The survey was made in parts of North Dakota, South Dakota and Minnesota, primarily in the area where shelterbelts are the most concentrated (fig. 2).

FIGURE 2. — Location of areas examined in the Northern Plains survey.

Intended routes were drawn on highway maps of the area before the fieldwork was begun. They were selected to systematically cover the area to be surveyed, but were generally along principal highways. During the fieldwork, periodic stops were made on these routes, generally at 5- to 20-mile intervals to examine shelterbelts or naturally wooded areas. Occasional detours were made when the distance between belts or woods was too long. West of the shelterbelt zone, where trees were scarce, examinations were made at distances greater than 20 miles apart. Cities and towns were almost always excluded from the survey. Specific locations outside the shelterbelt zone, such as the two units of the Roosevelt National Park, were also examined. In addition, five nurseries were checked for pests.

Shelterbelts and natural stands were surveyed by walking back and forth through them. In shelterbelts and nurseries, examinations were made up and down the rows as well. The number of passes made through each stand varied depending upon its size, but four passes were minimum for small areas. Extensive naturally wooded areas like the Turtle Mountains were sampled in several places but were considered to be one examination location.

Each tree along the line of survey was examined individually. The leaves, twigs and main stem were scrutinized for pests or signs of injury. The data were recorded on a portable tape recorder in the field, and specimens of most of the pests were collected for identification.

In all, 325 areas were examined between mid-June and early September of 1960. Of these, 285 were shelterbelts and windbreaks, 30 were naturally wooded areas, 5 were ornamental plantings on farms or in towns, and 5 were nurseries.

The tree and shrub species that were encountered in this survey and their frequency of occurrence are presented in table 1.

When a pest was identified, an attempt was also made to judge its importance in the sample plot. Occasionally the pest was no longer present at the time of examination, but the characteristic tree damage would generally serve to identify it. Broad infestation levels were established on the basis of the relative amount of host damage. For example, an estimation was made of the percent of defoliation, percent of shoots affected, or percent of leaves curled. Also, the proportion of the total number of host trees that were infested was estimated. A combination of these two estimates yielded an average percent infestation on all the

host trees in a sample area. The infestation levels were classified as follows.

No infestation	0 percent	Light infestation	6-25 perce
Trace of infestation	1-5 percent	Moderate infestation	26-60 perce
		Heavy infestation	61-90 perce
		Severe infestation	91-100 perce

TABLE 1. — *Tree and shrub species encountered in the Northern Great Plains survey and the frequency of occurrence*

Common name	Scientific name	Frequency of occurrence[1]
Green ash	*Fraxinus pennsylvanica* Marsh.	206
Boxelder	*Acer negundo* L.	181
American elm	*Ulmus americana* L.	165
Eastern cottonwood[2]	*Populus deltoides* Bartr.	146
Siberian elm	*Ulmus pumila* L.	138
Russian-olive	*Elaeagnus angustifolia* L.	107
Siberian peashrub	*Caragana arborescens* Lam.	92
American plum	*Prunus americana* Marsh.	88
Willow[3]	*Salix* spp.	59
Tatarian honeysuckle	*Lonicera tatarica* L.	45
Junipers[4]	*Juniperus* spp.	45
Common chokecherry	*Prunus virginiana* L.	42
Hackberry	*Celtis occidentalis* L.	22
Common lilac	*Syringa vulgaris* L.	22
Ponderosa pine	*Pinus ponderosa* Laws.	19
Blue spruce	*Picea pungens* Engelm.	14
Apple[3]	*Malus* spp.	12
Bur oak	*Quercus macrocarpa* Michx.	11
Peking Cotoneaster	*Cotoneaster acutifolia* Turcz.	6
Silver buffaloberry	*Shepherdia argentea* Nutt.	6
Sand cherry	*Prunus pumila* L.	6
Quaking aspen	*Populus tremuloides* Michx.	6
White spruce	*Picea glauca* (Moench) Voss	5
Honeylocust	*Gleditsia triacanthos* L.	4
Silver maple	*Acer saccharinum* L.	4
Pin cherry	*Prunus pensylvanica* L.f.	2
Skunkbush sumac	*Rhus trilobata* Nutt.	2
Eastern hophornbeam	*Ostrya virginiana* (Mill.) K. Koch	1
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco	1
Paper birch	*Betula papyrifera* Marsh.	1
Scotch pine	*Pinus sylvestris* L.	1
Grape[3]	*Vitis* spp.	4
Rose[3]	*Rosa* spp.	4

[1] This is the number of locations the species was observed out of 325 areas examined.
[2] Includes a few Plains cottonwoods (*Populus sargentii* Dode).
[3] Species not distinguished.
[4] Includes *Juniperus virginiana* L. and *J. scopulorum* Sarg.

A STARTING PLACE FOR FUTURE RESEARCH

Numerous forest insects and diseases attacking the native and introduced tree and shrub species in the Northern Great Plains were observed and collected in natural stands, shelterbelts, ornamentals and nurseries. These are described in the next section.

The data indicate that most of the forest insects and diseases are presently not the primary cause of death nor the limiting factor for tree or shrub survival. Deficient rainfall, temperature extremes, desiccating winds, and unfavorable soil properties usually are the most serious enemies of Great Plains trees.

However, in spite of the absence of high populations of particular pests at this time, the mere presence of a great number of different pests constitutes an enormous potential threat — especially in the shelterbelts. Since most of the belts are relatively young, changes in their structure due to continuing growth as well as changes in environmental conditions could easily result in the development of epidemics. Furthermore, the unique combinations of host trees and the generally adverse growing conditions may make even light infestations much more serious than they would be in naturally forested areas. Therefore, future research on these pests should be along the lines of: (1) studies for early detection of population buildups; (2) detailed studies of the biologies and ecologies of those pests giving indications of economic importance, and (3) tests to determine adequate control methods.

HOSTS AND IMPORTANT INJURIOUS AGENTS

For each host, the distribution and abundance of the most important pests encountered are described below. The hosts are listed in the order of their frequency of occurrence as shown in table 1.

A complete listing of *all* insects and diseases found on each host appears in table 2 in the Appendix. Table 3, also in the Appendix, lists the most injurious agents and their principal hosts, together with control measures if known or recommended in the literature.

Green Ash

Green ash was found in 206 out of the 325 locations. Eighty-four of these locations were considered free from insect or disease damage. Green ash seedlings were common in the deciduous nurseries since they were one of the most favored trees for shelterbelts and ornamentals. Several young shelterbelts had rows of saplings, and a few old stands had some decadent trees. Most of the samples, however, were medium-aged trees in shelterbelts.

Sphinx chersis (Hbn.) (Great ash sphinx)

The larvae of this insect were observed in 11 area, and every degree of defoliation from trace to severe was recorded for individual trees. Only one natural stand of large trees had evidence of this insect, and a few larvae were found feeding on 2-foot-high seedlings at the Bottineau Nursery. Most of the larvae were observed in young shelterbelts with saplings 2 to 6 feet high. Craighead (1950) stated that they appear to prefer saplings and sprouts. One sample area had at least one larva per tree with up to five on some. Nearly denuded saplings were often found with only one full-grown larva on each. These larvae may be 4 inches long when full grown and are capable of eating large quantities of food.

Eriophyes fraxiniflora Felt (Ash flower-gall mite)

Light infestations of this mite were noted in three areas. The conspicuous galls formed from the staminate or male flowers are unsightly in ornamental plantings but do not cause damage to the tree.

Megachile sp. (Leaf cutting bee)

Leaf injury by these insects was recorded from nearly 25 percent of the green ash locations. Also a trace to light injury was observed in three areas on common lilac and in one area on tatarian honeysuckle. The neatly cut circular holes were very conspicuous on leaves on the lower branches of the host. These insects seldom cause much injury, but one report from Montana[2] indicated that they can become very injurious to shade trees. Their "cutting" habits, together with feeding by other insects, could cause substantial injury.

Phyllophaga sp.[3] *(May beetle—white grub)*

One white grub was recovered from a green ash bed at the Ft. Lincoln Nursery. Occasional seedlings in the rows showed evidence of wilting and dying, and when pulled were found to be partially or totally without roots. According to the nursery manager that particular bed had recently been converted from sod. The insects had evidently been feeding on grass roots previously since none of the other beds showed any injury.

There is no doubt that white grubs can cause considerable damage to seedlings and transplants. The problem is and has been most important in the nursery, but occasionally newly planted shelterbelts and ornamentals may be injured. This is particularly true when old sodded areas are planted.

Boxelder

Boxelder was observed in 181 out of 325 areas examined. Like green ash, it was very common in nurseries and is a favorite tree for shelterbelts and ornamentals. Fourteen of the sample locations were

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[2] *U.S. Department of Agriculture, Insect Pest Survey Bulletin 12: 327. 1932 (Processed.) Per Craighead (1950).*

[3] *Identified by D. M. Anderson as Phyllophaga sp. near luctuosa Horn. Insect Identification and Parasite Introduction Section, Agricultural Research Service, Beltsville, Md.*

considered free from damage; all the others had at least some injury from pests, other animals, or environmental factors.

Proteoteras willingana (Kearf.) (Boxelder twig borer)

This borer was present in nearly 24 percent of the boxelder locations examined. It was widespread, and most of the infestations were classified as trace to light. In one area the infestation level was considered moderate.

In recent years this species has become somewhat troublesome in the Northern Great Plains, particularly in southern Saskatchewan and Manitoba. By 1955 it had caused considerable injury to boxelder in shelterbelts and ornamentals (Prentice and Hildahl 1956). Since then this infestation has declined (Prentice and Hildahl 1958, 1959). In North Dakota it was first noticed as a nursery problem but has since become a problem on shelterbelts. Each larva may kill a new shoot (fig. 3) and potentially could cause considerable injury.

Leptocoris trivittatus (Say) (Boxelder bug)

A trace of these insects was observed in two shelterbelts. Reports show that they are occasionally abundant on shelterbelt and ornamental boxelders (Severin 1948, Spawn et al. 1954).

Feeding is restricted primarily to the seeds and flowers of boxelder and other species of *Acer*, and secondarily to fruits of small plants. Therefore, this insect is relatively unimportant except when seed harvesting is desired.

When the insects are full grown they often seek winter quarters in homes, where they are a nuisance.

Hyphantria cunea (Drury) (Fall webworm)

In 1960 these insects were observed on boxelder at six different localities. Other species and the number of localities were: common chokecherry (3), American plum (3), American elm (2), eastern cottonwood (1), tatarian honeysuckle (1), Siberian elm (1), and willow (1). All the infestations examined were considered a trace or light, and generally no more than two complete branches were covered by the webs. One young chokecherry tree (fig. 4) was about one-third defoliated by webworms. Adjacent trees, however, were untouched.

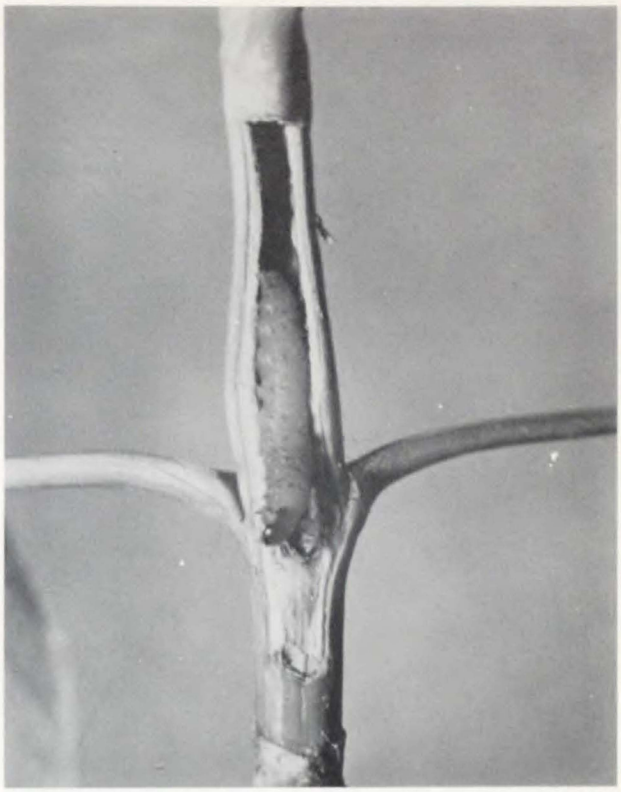

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FIGURE 3. — Larva and tunnel of the boxelder twig borer in a young boxelder shoot.

These widely distributed insects have been reported from about 120 species of deciduous trees and shrubs in the United States and Canada. They become numerous occasionally, particularly in the Southern States where there is more than one generation per year. A report from Benson County, N. Dak., in 1956 revealed several trees with 50 to 75 percent of the tree surface covered with webs of this insect (U.S. Agr. Res. Serv. 1956). In 1955 the larvae were particularly abundant in South Dakota and caused partial defoliation to a wide variety of hosts (Burge et al. 1955).

There is little doubt that fall webworm larvae, when abundant, are very destructive insects and should be kept under control, patricularly in young shelterbelts. The conspicuous webs permit easy detection.

Hyalophora cecropia (L.) (Cecropia moth)

Cecropia larvae were obtained from three areas in 1960. One nearly full-grown larva was found in each of two shelterbelts on boxelder. The trees were under 5 feet high, the larvae were fully

F-500795

FIGURE 4. — Defoliation and webbing on a chokecherry tree from larvae of the fall webworm.

grown, and defoliation amounted to a trace to light. A light infestation also occurred in a wildlife planting in McLean County, N. Dak.[4] Feeding was primarily on chokecherry, but some larvae were on other species of *Prunus* and also on Russian-olive.

Orcutt (1889, 1891) labeled the cecropia moth as one of the most destructive insects at that time in the Dakotas. It was a ruthless feeder on several species of trees, and tree-growing was nearly abandoned. Numerous other reports (Williams 1893; Severin 1918, 1947, 1948; and Johnson and Cobb 1928) further stressed the damaging ability of this insect to Plains trees. Trees in Manitoba and Saskatchewan have had their share of serious damage also. Some shelterbelts in 1942 were up to 90-percent defoliated (Peterson 1947).

This insect may become 3 to 4 inches long when fully grown. It consumes a great deal of foliage and is a general feeder. Intensive work on its life history is in progress in Canada (Peterson 19[illegible] Peterson and Worden 1960). Peterson (1947) re ported that the egg parasite (*Telenomus grapto* was instrumental in reducing cecropia populatio in Canada. Also, a wilt-like disease greatly reduce the very heavy 1942 infestation in the spring o 1943.

Contarinia negundifolia Felt (Boxelder go midge)

Eight (4 percent) of the boxelder areas e amined had the boxelder gall midge in 1960; a were in North Dakota. The infestation level, rate by the quantity of galls on each tree, ranged fro trace to light. Most areas were shelterbelts, bu two natural stands had the insects.

An insect, probably this species, was reare from galls on boxelder leaves at Ames, Ia., prio to 1900. According to Felt (1908) the infestatio was considered "quite serious to boxelder." I was not explained whether this referred to actua injury to the tree or whether the galls were jus numerous. The latter is suspected. Damage b this insect probably results from premature lea fall.

Boxelder blight

Boxelder blight was the most common disease observed in the Plains in 1960. It was found in 130 locations, nearly 72 percent of the boxelder areas examined. This included trees in nurseries (fig. 5A), ornamentals on city streets (fig. 5B), and trees in shelterbelts (fig. 5C). Those in the nursery showed the least amount of blight in 1960. No tree mortality was observed. Definite blight symptoms, though less pronounced, were also observed on the following species: Siberian elm (24 percent), American elm (15 percent), green ash (4 percent), willow (3 percent), and common chokecherry (2 percent).

This "diseased condition" of boxelder foliage was first observed around 1951 in northwestern North Dakota (Beckwith and Anderson 1957). It has since been observed throughout North Dakota, South Dakota, and parts of the adjacent States as well as the Prairie Provinces of Canada. The symptoms are easily recognized by the small chlorotic curled leaves on the new shoots (fig. 5A). Trees of all sizes and of different species may be affected, but injury to nursery stock is usually most pronounced.

[4] *Personal communication, Paul E. Slabaugh, Lake States Forest Experiment Station, Bottineau, N. Dak.*

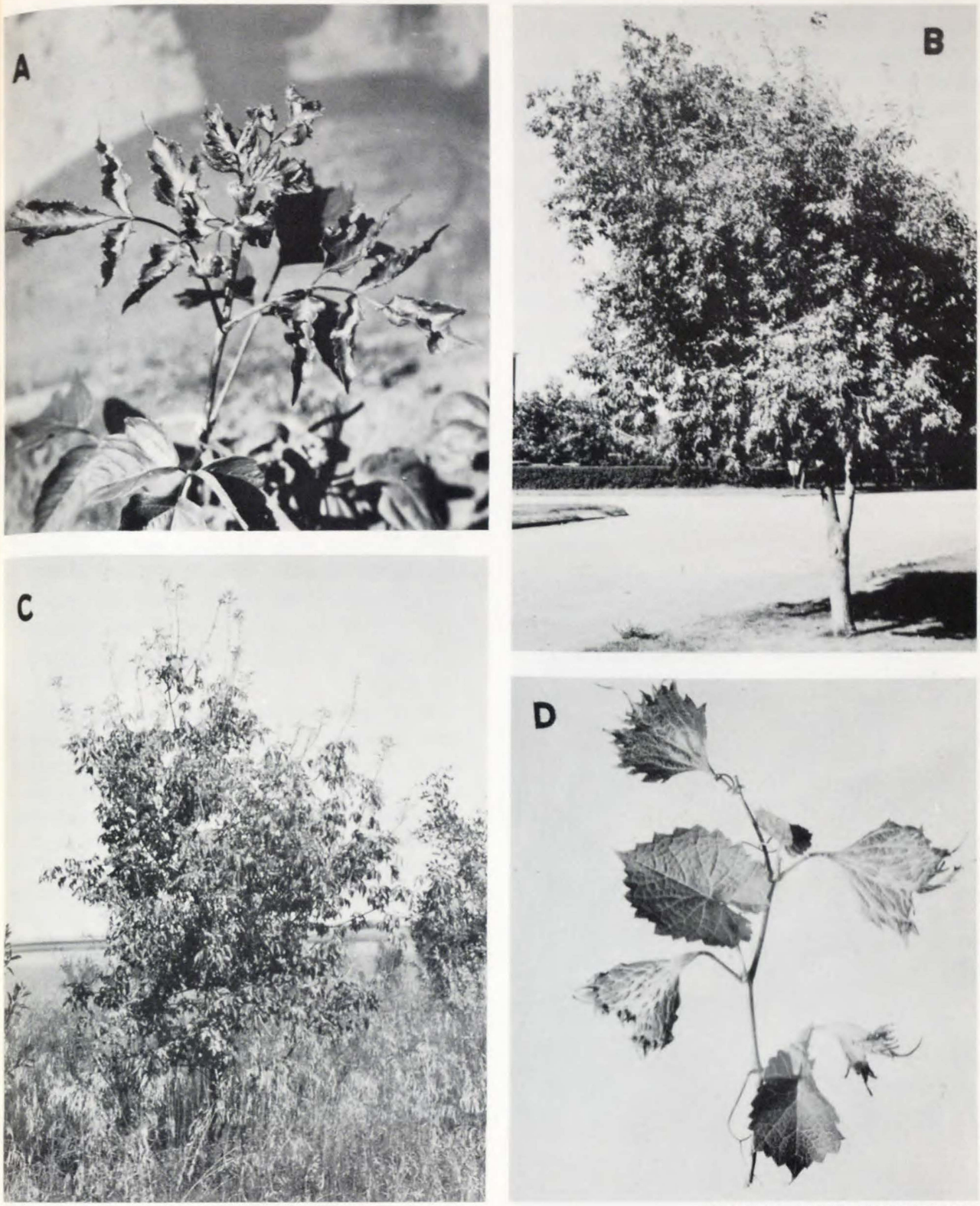

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FIGURE 5. — Boxelder blight deformation on: *A*, young boxelder seedling, *B*, ornamental, *C*, shelterbelt tree, and *D*, grape.

Several factors have been suspected as the possible cause of blight. These include viruses, insects, fungi, bacteria, environmental factors, or physiological reactions, or a combination of some of these. Although the cause is not yet certainly determined, the general consensus now is that blight is caused by a physiological reaction of the plant to the herbicide 2,4-D. This herbicide is used extensively to control weeds in small-grain farming.

The evidence in favor of 2,4-D as the damaging agent is: (1) Blight symptoms begin to show up on the new shoots each season about the same time as herbicide spraying begins. (2) Some shoots that are heavily blighted may show recovery at the terminals later in the season — at about the time herbicide spraying is terminated. (3) Cotton and grape, which are known experimentally to be very susceptible to 2,4-D injury, when placed in the nursery with boxelder seedlings developed very pronounced blight symptoms (fig. 5D). Similar plants grown indoors were without injury. Wild grape plants found in four blighted natural stands in 1960 all showed severely blighted leaves. (4) Most observers agree that blight on boxelder was never observed prior to extensive use of herbicides in the Plains.

Some observers argue that the blight has been seen in areas quite distant from those sprayed with herbicides. However, considering the flatness of the Plains, the frequent strong winds, and presumably the small amount of herbicide that is needed to produce the symptoms, several miles might separate the source and the effect.

If a herbicide is the cause of this blight, little can be done to prevent it at present. Herbicides are used abundantly in Great Plains agriculture to destroy noxious weeds.

F-500798

FIGURE 6. — Curled leaf of American elm injured by the woolly elm aphid. Note the lady bird beetle feeding upon the aphids. (X 1)

American Elm

American elm was recorded in 165 locations. Of these, 55 areas were without apparent injury. Although several pests were recorded on American elm, only a few were considered actually or potentially detrimental.

Eriosoma americanum (Riley) (Woolly elm aphid)

This aphid was found in 70 of the 165 locations. Damage was estimated by the percent of curled leaves per tree (fig. 6). Every tree examined in the town of Bottineau, N. Dak., showed heavy injury. Shelterbelts and natural stands showed the following damage and number of locations observed: moderate (2), light (12), and trace (55). Other reports[5] from North Dakota confirm the widespread distribution of this insect.

Cimbex americana Leach (Elm sawfly)

This insect is the largest North American sawfly and is distributed widely in the northern United States and southern Canada. Two fully grown larvae were obtained from one large elm in Brookings County, S. Dak., in the survey. Injury from their feeding was insignificant and considered a trace, but Craighead (1950) stated they are vigorous defoliators and may cause serious injury by gnawing into the bark of the twigs. Elm and willow are the favored hosts, but larvae have

[5] *Taken from Cooperative Economic Insect Reports for 1960. U.S. Agr. Res. Serv., Plant Pest Control Division.*

been obtained from alder, basswood, birch, maple and poplar. Williams (1893) considered it the worst enemy to willows in South Dakota. It was also found in several locations in South Dakota in 1956 and 1958 on both elm and willow (Lofgren and Hantsbarger 1957, Hantsbarger and Mast 1959).

Colopha ulmicola (Fitch) (Elm cockscomb gall)

The galls of this insect, which are very conspicuous, were observed on two shelterbelts in North Dakota and one in South Dakota. In each location, the infestation was rated a trace.

Nymphalis antiopa (L.) (Mourning-cloak butterfly)

The larva (called the spiny elm caterpillar) of the mourning-cloak butterfly was not observed in this survey. Nevertheless, this pest has been reported in the Plains in recent years. The larvae were prevalent on American elm seedlings at the Ft. Lincoln Nursery in 1958 and control was deemed necessary.[6] They occasionally become abundant on ornamental and shade trees (Craighead 1950) and especially in shelterbelts in the Plains (Hantsbarger and Ferrell 1959).

Elm, willow, poplar and hackberry are some of the favored hosts. Damage to individual trees could be heavy because the insects are gregarious. There are usually an early and a late generation in the same season, which further increases defoliation.

Corythucha ulmi O.&D. (Elm lace bug)

The nymphs and adults of this lace bug were found in nine locations on American elm in North Dakota. No specimens were observed in South Dakota. The injury was rated as a trace in seven areas, light in one, and light to moderate in one. Five areas were shelterbelts and four were natural stands. The area with a light to moderate infestation had a trace of lace bugs on adjacent Siberian elms also. In all other areas mentioned, Siberian elm was absent.

Little is known about the life history of this species. Heavy infestations cause serious foliage discolorations (Craighead 1950).

[6] *Personal communication, Paul E. Slabaugh, Lake States Forest Experiment Station, Bottineau, N. Dak.*

Cottonwood

One of the favorite species in past plantings, cottonwood is still an abundant tree on the Plains. It grows particularly well on moist sites, especially along streambanks. *Populus deltoides* was the predominant species observed, but a few *P. sargentii* were located in western North Dakota in the lowlands of the Roosevelt National Park. Of the 146 areas examined containing cottonwoods, 51 areas were without injury.

Pemphigus populicaulis Fitch (Poplar stem gall aphid)

This insect gall-maker was the most conspicuous pest of cottonwoods. Of the 146 areas, 29 had some indication of attack by this insect; 25 had a trace of galls, and 4 had a trace to light. This insect is widely distributed, and it generally prefers larger trees. Injury from gall formation appears to be slight; the only consequence is possibly some premature leaf drop. Parasites of various types and predators, too, are often beneficial in holding the aphids at low population levels.

Neothomasia populicola (Thos.) (Aphid)

Colonies of this aphid were observed in 35 localities. Unlike the gall-former *Pemphigus populicaulis*, this species was not conspicuous. It appeared to prefer young trees or sprouts, and fed mostly upon the smaller stems. Stem discolorations were evident in a few instances. In almost all the infested sample locations, one or very few colonies were located on each tree, and injury was considered a trace. Two areas had more, and were given a trace to light rating. In one area, which had only saplings and suckers, damage was considered moderate.

Mordwilkoja vagabunda (Walsh) (Poplar vagabond aphid)

The conspicuous gall formed by these aphids has been reported previously in the Plains (George 1936, Severin 1948), but was not abundant in 1960. In all instances individual trees were attacked, and adjacent trees were usually untouched. The galls caused deformation of twig tips, but no serious injury could be attributed to them. The life history of the poplar vagabond aphid has recently been worked out by Ignoffo and Granovsky (1961).

Chrysomela scripta Fab. (Cottonwood leaf beetle)

A few of the adult insects were found on cottonwood seedlings at the Towner Nursery in 1960. The infestation was considered a trace at the time of collection.

This insect has had a long history as a destructive pest of cottonwoods, poplars and willows in the Northern Great Plains (Orcutt 1891, Williams 1893, Ware 1936). Ware (1936) cited *C. scripta* as the most destructive leaf feeder, second only to grasshoppers, in South Dakota. It was a serious pest on willows in South Dakota shelterbelts in 1946 (Severin 1947), and it was again present there in 1957 (Lofgren and Hantsbarger 1958).

Alsophila pometaria (Harr.) (Fall canker-worm)

One larva of this insect was recovered from one cottonwood tree. Although apparently not abundant in 1960, the insect has caused considerable damage in the past. It is mentioned in Canadian reports (1951-1958)[7] as one of the most injurious pests of deciduous trees in the agricultural areas of Manitoba and Saskatchewan, where it was especially serious on shelterbelts and ornamentals. Boxelder, green ash and American elm are the primary hosts, and when these species are present in a belt, other species may be denuded as well.

Siberian Elm

A common shelterbelt species, Siberian elm (sometimes incorrectly called Chinese elm) was observed on 138 planted sites, 94 of which showed no apparent injury. One area had a trace of fall webworm damage. The remaining areas had a trace to light of boxelder blight injury.

Russian - olive

Russian-Olive appeared to be one of the healthiest tree species in the Plains. In 90 of 107 locations no obvious injury was recorded. Although the tree is somewhat drought-susceptible, very little drought injury was observed. Because it is low and bushy when young, it has been a very popular shelterbelt tree in the past for outside rows. One undesirable feature is the heavy spines on the stems. A few farmers refused to plow their belts because of this. Furthermore, this species is short-lived. It is no longer being planted extensively in the Dakotas.

Estigmene acrea (Drury) (Salt-marsh caterpillar)

This woolly larva was observed twice in the survey. One larva was collected on a Russian-olive tree and another on a sand cherry shrub. In each case the feeding injury was classed as a trace. The insect is generally a low shrub feeder and is not known to be a particularly important forest pest.

Dieback

About 9 percent of the Russian-olive stands examined had some degree of dieback. In one area injury was severe, in one moderate, and in eight a trace to light. Whether this is caused by a biotic agent is not yet known.

Siberian Peashrub (Caragana)

The Siberian peashrub is considered one of the most valuable shrubs in shelterbelt plantings. In the outside rows of belts, or as an ornamental, it makes a dense sturdy hedge useful in breaking wind and trapping snow. Caragana was recorded from 92 locations, and 32 were without noticeable damage. Much of the injury, however, was observed late in the season; had early sample areas been resurveyed, more damage due to blister beetles would undoubtedly have been found. These beetles are particularly troublesome in the early summer.

Melanoplus spp. (Grasshoppers)

In 1960, a reasonably wet year by Plains standards, grasshopper populations were thought to be somewhat lower than might be expected in drier years. Consequently, damage to shelterbelts was probably lower as well. Grasshopper feeding was observed in eight locations. Shrubs in the outside rows, particularly Siberian peashrub, had the worst defoliation. Injury to individual Siberian peashrubs was classed as moderate to heavy in most instances. An occasional plant was lightly debarked. Other species with injury classed as trace to light and their frequency of occurrence were: honeysuckle (3), plum (2), boxelder (2), American elm (1), hackberry (1), Russian-olive (1) and willow (1).

[7] *Annual Report of the Forest Insect and Disease Survey, Canada Dept. Agr., years 1951 through 1958.*

The predominant species of grasshoppers in the shelterbelt zone and adjacent areas of North Dakota and South Dakota are *Melanoplus bivittatus, M. bilituratus, M. packardii, M. femurrubrum.* and *M. differentialis* (U.S. Agr. Res. Serv. 1960). Their normal food hosts are many and include alfalfa, small grains, soybeans, flax and corn. Since grasshoppers are general feeders, any or all species of trees and shrubs in the shelterbelts may be attacked as well. Even conifers like ponderosa pine are not immune.

During the survey it was noted that shelterbelts adjacent to cornfields always had lower grasshopper populations than those next to grainfields. Grasshopper injury did not become particularly noticeable until after the crop adjacent to the belt was harvested. Then, with their normal food removed, they migrated to and concentrated on the trees and shrubs (fig. 7).

Epicauta subglabra (Fall) (Caragana blister beetle)

Two forms[8] — one black and one gray — of this species were collected in 1960 in three areas in North Dakota. At the Bottineau Nursery, one young Caragana bed had light to heavy feeding on individual plants. Control was not attempted, but malathion had been successfully used previously. The pest was also found at the Towner Nursery, but the beds were sprayed shortly after their discovery and control was successful. The blister beetle was collected in one shelterbelt and caused a trace of injury (see cover picture). Caragana in several other belts showed some trace to light injury, but no insects were found. These insects are difficult to locate in this type of survey because they are present for only a short period in any one spot.

Lytta nuttallii Say (Nuttall blister beetle)

The nuttall blister beetle was taken from Caragana plants at the Towner Nursery in 1960. An insecticide was used as a control measure. Of the five species of insects present at Indian Head, Sask., in 1960, *L. nuttallii* was the most important. It became especially numerous in 1958-59; and consequently, experiments on control were started in 1959 (Peterson and Worden 1960).

[8] *Determined by T. J. Spilman, Insect Identification and Parasite Introduction Section, Agricultural Research Service, Beltsville, Md.*

F-500793

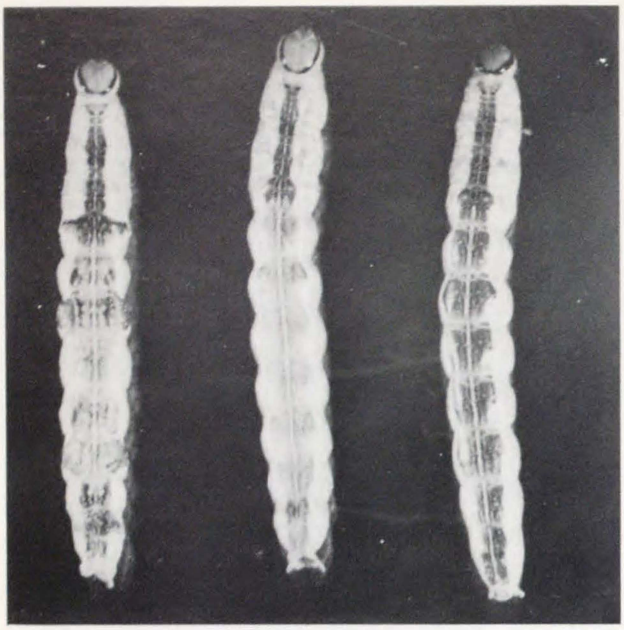
FIGURE 7. — Heavy grasshopper defoliation of a Siberian peashrub in a shelterbelt adjacent to a freshly harvested field.

American Plum

A tree well adapted to the Plains conditions, plum is frequently located in natural areas, orchards, and shelterbelts. It was observed in 88 locations, of which 59 were without injury.

Heterocampa manteo (Dbldy.) (Variable oak leaf caterpillar)

This general feeder (fig. 8) was collected at one location on plum near Huron, S. Dak., where it caused only a trace of injury to one tree. Its characteristic feeding (fig. 9) can be found on several species of plants. Experience with this insect in the Eastern States shows that populations occasionally increase enormously and heavy defoliation occurs. However, feeding is late in the season, and trees generally can withstand 3 years of defoliation. Since heavy populations rarely last longer than 3 years, control is rarely recommended. The situation may not be the same in the Plains where drought conditions are more likely to occur. Plains species may not be able to withstand several defoliations and may succumb before the insect population declines.



F-496930

FIGURE 8. — Larvae of the variable oak leaf caterpillar showing some of the variations in markings. (X 1.8)

Willow

Various species of willow, an occasional shelterbelt tree, are also common naturally in moist locations. Fifty-nine sampling points had some species of willow, and 28 were without noticeable damage.

Pontania desmodioides Walsh (Gall sawfly)

Galls of this minute sawfly were the most common and most conspicuous pest on willow. Thirteen out of 59 locations harbored the insect. Four locations were rated as light injury; the others had a trace. The area enclosing the gall is the only damage caused to the leaf, and damage has never been sufficiently important to warrant artificial control.

Pontania pomum Walsh (Willow apple gall midge)

These yellow galls, made by a minute sawfly, were observed on willow in three locations. Injury was only a trace in all instances. Actual damage is done to immediate area enclosing the gall and, like the related *P. desmodioides*, it has never been sufficiently abundant to warrant artificial control.

Hemileuca nevadensis Stretch (Nevada buck moth)

This insect is a western species that ranges into the Great Plains and feeds on poplars and willows. It was not collected in 1960, but specimens were collected on willow in Ransom County, N. Dak., in 1958.[9] Damage was not serious then, but the insects are large and feed gregariously so that injury can occur. One report for 1922 stated that they were abundant and damaging on cottonwood in Nebraska (Craighead 1950).

Rhabdophaga strobiloides (Walsh) (Willow cone gall midge)

This willow gall midge produces unusual galls resembling a cone. The gall was collected in one natural area near Cavalier, N. Dak., and injury was considered a trace. This insect has never been an important economic pest.

Tatarian Honeysuckle

The tatarian honeysuckle is a desirable shelterbelt and ornamental shrub. It was recorded from 45 locations, and 39 were without injury. Of the

[9] *Personal communication, Paul E. Slabaugh, Lake States Forest Experiment Station, Bottineau, N. Dak.*

F-496929

FIGURE 9. — Basswood leaf showing characteristic skeletonizing (right) by very young larvae and free feeding (left) by the older larvae of the variable oak leaf caterpillar. (X .7)

remaining areas, three shelterbelts had a trace to light amount of grasshopper feeding; one area had a trace of injury from the fall webworm; and one a trace to light injury from leaf cutting bees. Tatarian honeysuckle seedlings grown at the Towner Nursery had a light infestation of blister beetles (*Lytta* sp.).

Junipers

Both *Juniperus virginiana L.* and *J. scopulorum* Sarg. were observed in the Plains but were not distinguished in the survey. *J. scopulorum* was the common shelterbelt inhabitant; it is desirable since it is bushy, slow growing and drought resistant.

Mites

Several of the areas examined had evidence of webbing by mites and occasional browning of the foliage, but injury was very light in all cases. Several records show, however, that species of *Tetranychus* and *Oligonychus* have caused considerable injury to junipers in the Plains of the United States and Canada (S. Dak. State Col. Agr. Expt. Sta. 1956, Prentice and Hildahl 1959). Kelthane was used in Canadian experiments to control *Oligonychus ununguis*. Moderate to severe infestations of spider mites were recorded for spruces and juniper for several areas of North and South Dakota in 1960 by others (U.S. Agr. Res. Serv. 1960).

Gymnosporangium juniperi-virginianae Achw. (Cedarapple rust)

The galls of this disease were observed in two locations on junipers. Only a few galls were on the trees, and the infestation was considered a trace. The problem is more important on the apple host in orchards where both the leaves and the apples are infected.

Common Chokecherry

One of the favorite shelterbelt species, the common chokecherry is also frequently found in natural stands. Most nurseries grow a great deal of this species. Forty-two locations had chokecherry shrubs in various age and size classes. Of these, 16 areas were without insect or disease damage.

Dibotryon morbosum (Schw.) T. & S. (Black knot of cherry)

The black knots of this Ascomycete were observed in four localities on chokecherry and in one on sand cherry. Infestation and injury were a trace in all instances, and only one or a few trees were attacked at each location.

A potentially detrimental pest of *Prunus*, this disease in the past has killed trees in the Plains (Williams 1893, Severin 1918). Usually small twigs are infested; when the disease spreads onto the bole of the tree, severe damage occurs.

Coccomyces lutescens (Cherry leaf spot ("shothole"))

This disease was by far the most detrimental agent to chokecherry in 1960. Diseased foliage was observed in 3 nurseries, 2 natural areas, and 13 shelterbelts. Damage was most acute in nurseries, where spotting ranged from light to heavy with no immune plants. The large shrubs in the two natural areas had a trace of the fungus. Most of the shelterbelts had a trace to light infestation, and one was rated moderate. Two areas containing American plum had a trace of this leaf spot also. The disease has been recorded from the Plains nurseries since the early 1900's (Severin 1919), and Engstrom and Stoeckeler (1941) observed it on several species of *Prunus*. In recent years the Bottineau Nursery has lost up to 50,000 seedlings annually from this fungus.

Malacosoma lutescens (Prairie tent caterpillar)

Larvae of the prairie tent caterpillar were taken from four locations in North Dakota in 1960. Specimens and webs were scarce; and even though the larvae were nearly full grown in each case, the damage was only a trace. At the Sully's Hill Game Preserve near Devils Lake a few bushes were infested. These few insects are the remnants from a large infestation in 1958.[10] At that time, 3,000 acres of natural stands were defoliated. Both *Malacosoma disstria* and *M. lutescens* were involved. The prairie tent caterpillar was responsible for damage only to the low-growing shrubs, particularly serviceberries.

Chokecherry bushes in the north and south units of the Roosevelt National Park also had a few tent caterpillars this year; defoliation was just a trace. The other area was at the Bottineau Nursery. A few seedlings were partially stripped, but

[10] *Letters on file, Lake States Forest Experiment Station.*

an extensive examination showed only a few insects. Here too, the damage was considered a trace.

Archips sp. (Leaf webber)

A leaf webbing tortricid was obtained from chokecherry bushes in Roosevelt National Park in 1960. The damage was rated light to moderate. Since chokecherry is one of the more important shrubs in this nearly treeless area, insects of this nature should be watched closely.

Alsophila pometaria (Harr.) (Fall canker-worm)

This highly destructive insect was found at just one location on chokecherry in the Bottineau Nursery. It caused no appreciable damage to the seedlings, and the infestation was considered only a trace.

Aphis cerasifoliae Fitch (Aphid)

This aphid caused a trace of leaf curling on chokecherry seedlings at the Bottineau Nursery. No more than two leaves on a plant were infested, and only a few plants had leaf curl. Overall damage to the nursery was considered a trace.

Hackberry

Hackberry is found in natural stands, and occasionally in shelterbelts; it is also used as an ornamental. In 5 of the 22 areas where the species was observed the trees were free from insect or disease injury. One area had a trace to light amount of grasshopper injury. The trees in the other areas were injured by a gall insect.

Hackberry gall (Species undetermined)

This hackberry gall insect was the most prevalent and detrimental pest on hackberry in 1960. It was recorded in 16 out of 22 areas. Rated by the percent of leaves infested, six areas had a trace, five light, four moderate, and one a heavy infestation. Only one area showed some dieback but this could have been caused by other circumstances.

Common Lilac

Although not a native species, the common lilac is widely planted in shelterbelts and as ornamentals. Nineteen of the areas examined in the survey were without injury. The remaining three area had a trace to light injury from leaf cutting bee (*Megachile* sp.). This tree species also may b attacked by various pests such as the lilac bore (*Podosesia syringae syringae* (Harris)) or th cecropia moth (*Hyalophora cecropia* (L.)), bu none were found in the survey.

Ponderosa Pine

Ponderosa pine has become one of the most de sirable shelterbelt trees. It is difficult to establis but once started, it grows well and is particularl drought resistant. Nineteen locations had th species, of which 17 were without injury.

Rhyacionia frustrana bushnelli (Tip moth)

This highly destructive insect has been record ed frequently in the Great Plains, but most of th damage has occurred in Nebraska. In 1960 the in sect was abundant in one area of the DeSmet For est in South Dakota.[11] Nearly every tree in a block planting was infested. The pines at the U.S. De partment of Agriculture experimental plots at Man dan, N. Dak., were the only other trees observed with injury. Those trees were large and had been infested in 1959. No insects were observed there in 1960.

An examination of a hillside planting along a reservoir near Yankton, S. Dak., in 1959 by members of the Lake States Station also revealed damage by the tip moth. About half of the 30,000 transplanted ponderosa pine seedlings were infested. The stock had been infested in the nursery prior to planting.

So far, ponderosa pine is not planted widely enough to cause an insect epidemic in either North or South Dakota; but as planting of this species increases, the problems will likely become more acute.

Damping-off

Damping-off was observed only at the Towner Nursery in 1960. The young ponderosa pine beds were under experimental treatment for control. Areas that had been treated showed better survival than the untreated areas.

Damping-off is a nursery problem that war-

[11] *Reported by Paul E. Slabaugh, Lake States Forest Experiment Station, Bottineau, N. Dak.*

rants considerable attention. It is not a single disease but is a collective term applied to several species of pathogenic fungi found on the roots of several species of seedlings. Damping-off in one area may be different in character from that in another area. It exists in two major types: (1) preemergence results in destruction of seeds or newly germinated seedlings; (2) postemergence results in root deterioration and kills the seedlings after they emerge and up until 3 or 4 weeks later.

Several species of broadleaf seedlings (Wright 1944) and most species of conifers except junipers (Canada Dept. Agr. 1955) are susceptible to damping-off fungi. *Rhizoctonia solani* Kuhn and *Pythium ultimatum* Trow. are the most frequently identified isolates in damping-off studies.

Control may be difficult because the specific treatment needed depends on the host, fungus and soil properties. But it is essential, or entire beds of nursery stock may be wiped out.

Ceramica picta (Harr.) (Zebra caterpillar)

The zebra caterpillar, a widely distributed general feeder also known as a climbing cutworm, is frequently found on forest and shade trees but seldom is abundant. This insect was not collected in 1960, but there is one report of its presence on pines in the Towner Nursery in 1958.[12] When abundant, damage could easily be severe on small plants.

Blue Spruce

Blue spruce has been introduced into the Plains as a desirable ornamental and shelterbelt tree. It was found at fourteen locations, and all the trees examined were without injury.

Apple

Apple trees were observed in 12 locations in the survey. Nine of these were shelterbelts; the other three were rows of trees along edges of nurseries. No orchards were examined. Ten areas were without injury.

Gymnosporangium juniperi-virginianae Schw. (Cedarapple rust)

This disease was observed in one location on a few apple trees adjacent to a nursery. The infestation was considered light and not particularly detrimental to the host. The problem is most acute in orchards when both the leaves and apples are rusted.

Sphinx drupiferarum A. & S. (Hackberry sphinx)

One larva of this general feeder was obtained from a young crabapple seedling in the Ft. Lincoln Nursery. A potentially destructive pest, it is held under strict control at this nursery by insecticides. Except for this one seedling, no injury was noted, and the insect was not found elsewhere.

Bur Oak

Bur oak trees are native to the Northern Plains and are found in many natural areas. Occasionally they are used in shelterbelts, since they are long-lived and very drought resistant.

Both young and old trees were found at 11 different locations. Seven of the localities were natural stands — the most extensive one being in the Turtle Mountains in North Dakota. The others were young trees in shelterbelts.

Corythucha arcuata (Say) (Oak lace bug)

This sucking insect, observed in eight locations, was the most common and detrimental pest of bur oak. The worst infestations were located in large natural stands such as the Turtle Mountains, the Devils Lake Region, and the Pembina Hills. The overall lace bug injury in these three extensive areas was rated moderate to heavy. Occasional trees were individually rated trace or light. The infestations in small natural stands and shelterbelts were given a light rating.

The underside of the leaves of the infested oaks often had dozens of nymphs and adults, plus hundreds of eggs. The leaves showed heavy stippling from the insect feeding, and many were chlorotic early in the summer. Second-generation infestations were heavier in late summer, and some browning of leaves was observed. Feeding by the insects results in premature leaf fall. Damage in drought years probably would be especially serious.

Oak galls

Several types of galls were obtained from bur oaks. They were identified as: *Disholcaspis* sp.; *Ac-*

[12] *Collected by Paul E. Slabaugh, Lake States Forest Experiment Station, Bottineau, N. Dak.*

raspis macrocarpae Bass.; *Andricus ignotus* (Bass.); *Acraspis villosa* Gill.; *Xystoteras poculum* Weld; *Philonix nigra* (Gill.); and *Adleria dimorpha*. None was ever found in more than two localities, and each was always infrequent enough to be classified as a trace. Because of low populations and the endemic nature of these organisms, they can be considered unimportant at present in the Plains.

Peking Cotoneaster

Cotoneaster is a shrub planted occasionally in hedges and shelterbelts in the Plains. It was found in six shelterbelts; cotoneasters in five of these areas were free of insects.

Datana ministra (Drury) (Yellow-necked caterpillar)

Several colonies of this insect were present on cotoneaster shrubs in a shelterbelt in Jerauld County, S. Dak. Most of the plants were without damage, but injury on the few with colonies was rated light. These general feeders also attack other species of shrubs and trees, and in some years may cause considerable defoliation.

A tortricid (Species unknown)

A light to moderate infestation of small tortricid larvae (species not identified) was observed concurrently with *Datana ministra*. Their feeding caused considerable browning of the leaves, and frass-covered webs were quite evident.

Silver Buffaloberry

The silver buffaloberry is occasionally used in shelterbelts and also can be found growing naturally along river bottoms and ravines. Molberg (1954) stated that its susceptibility to heart rot and wind breakage discourages extensive planting. It was observed in six shelterbelts in both North Dakota and South Dakota. Five of the locations were without injury. One belt had a trace of feeding from the larvae of *Datana* sp. There were only a few insects, and most of the plants were uninjured.

Sand Cherry

A native of the Plains, this shrub is occasionally used in shelterbelts. It was observed in six shelterbelts in North Dakota. In four belts there was no apparent damage; in the other two areas a trace of defoliation by the salt-marsh caterpillar and a trace of black knot disease were noted.

Quaking Aspen

A rather common tree in some localities, quaking aspen is generally considered one of the important wood-producing species in the Plains. As it is fairly susceptible to drought, it is seldom used in shelterbelts. Five of the six areas in which aspen was located in the survey were natural stands—the largest one being the Turtle Mountains. One row of small aspen was found in a shelterbelt.

Hypoxylon pruinatum (Klotsche) Cke. (Hypoxylon canker)

This parasitic disease was observed only in the Turtle Mountains. While it was widespread there its damage was classified as light. Some of the infected trees had broken over and were dead.

Saperda calcarata Say (Poplar borer)

The poplar borer was not seen during the survey. The insect is known to be present in the Turtle Mountains, but populations are probably light. It seldom becomes abundant enough to kill the trees outright, but damage, such as wind breakage and poor-quality lumber, and the possible introduction of tree diseases make this an important insect.

A leaf beetle (Species unkown)

Both larvae and adults of leaf beetles were obtained from aspen leaves in the Turtle Mountains. On some trees they were heavily clustered (fig. 10) on the leaves and caused light to moderate defoliation. This group of beetles has had a long and destructive history in the Plains, and representatives of the group are still abundant in localized areas.

White Spruce

White spruce, which is not native to the Plains except in the Black Hills and parts of western Canada, was observed in five shelterbelts, all in North Dakota. Three of the areas were young plantations with trees no more than 1 foot high. One belt of these small trees, which separated two grain fields, was almost completely hidden by large weeds. The

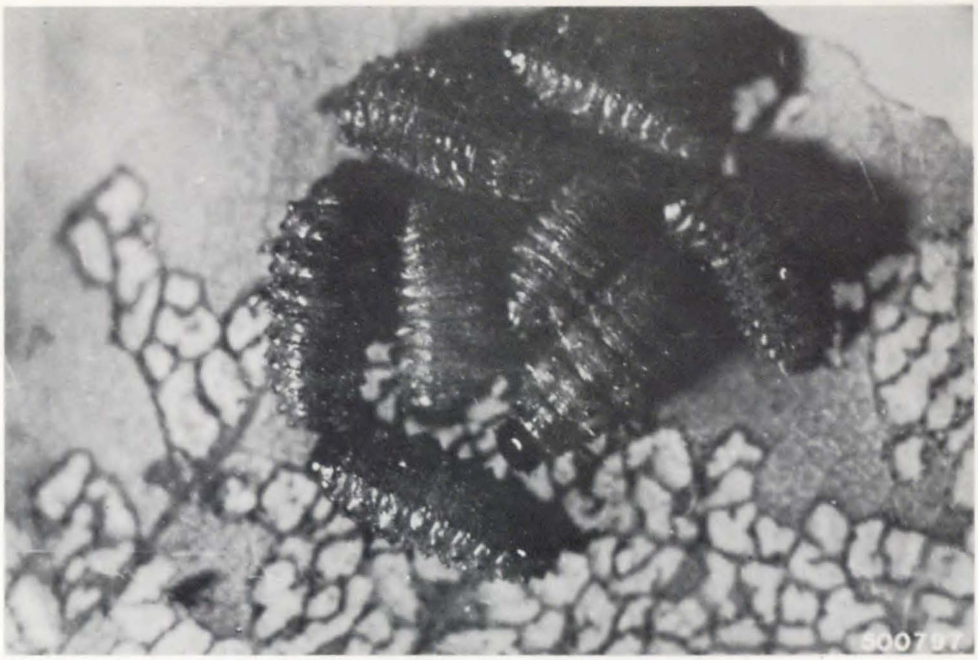


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FIGURE 10. — Cluster of leaf beetles feeding on aspen leaf.

weeds were heavily infested with grasshoppers, but at the same time the weeds protected the conifers from them. A trace of grasshopper feeding was found on a few trees that were partially exposed.

Honeylocust

Small honeylocust trees were found in four shelterbelts in South Dakota. Only one area (Yankton County, S. Dak.) showed a trace to light damage from a lepidopterous leaf miner infestation. These insects were tentatively identified as *Cameraria* sp., a genus of small insects with variable mining habits. Heavy infestations reduce host vigor and cause unsightly plants. They seldom become important economic pests. Although honeylocust may be damaged by these insects, the tree occurs only very rarely in the Northern Great Plains.

Silver Maple

Silver maple was found at four locations in North and South Dakota. Trees from shelterbelts, natural stands and city park plantings were sampled. The trees in one open natural stand were apparently injured slightly by wind action. The trees in one shelterbelt had light to moderate dieback; in some cases one-half of the crown was dead. No specific cause was apparent.

Several silver maple in the DeSmet Forest, S. Dak., were reported infected with tar spot (*Rhytisma acerinum* (Pers.) Fr.).[13] When severe, this disease causes premature leaf drop, but in general, injury is not serious enough on forest trees to warrant control. Infected nursery stock should be treated, however. Destroying the fallen leaves lessens the severity of the infestation the next year.

Pin Cherry

Pin cherry is used occasionally in shelterbelts, but it may also grow naturally in wooded areas of the eastern part of the Plains. It was found in two shelterbelts in North Dakota. No pests were observed, but it should be stressed that pin cherry is subject to injury by most of the pests common to other species of *Prunus*. The fall webworm and black knot are two examples.

Skunkbush Sumac

Skunkbush sumac, a shrub, was observed in two shelterbelts. One planting in North Dakota was without injury. The other in South Dakota showed a trace of defoliation, but no pests were observed.

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[13] *Reported by Paul E. Slabaugh, Lake States Forest Experiment Station, Bottineau, N. Dak.*

Eastern Hophornbeam

The eastern hophornbeam, locally known as ironwood, was observed once in a natural stand in South Dakota. The trees were without noticeable injury. Even though found in natural stands, it is not one of the important Plains species. Occasionally it is planted as an ornamental.

Douglas-fir

Douglas-fir was observed in one shelterbelt in North Dakota (Bottineau County). These 4-foot-high trees were well established and without apparent insect injury.

Paper Birch

This species was observed in two localities — in an ornamental planting and in the Turtle Mountains in North Dakota. The specimens that were examined were uninjured. However, larvae of the carpenterworm (*Prionoxystus robiniae* Peck) have been obtained from trees in the Turtle Mountains.[14] Severe epidemics have been reported in Nebraska in the past,[15] and Ware (1936) stated that the carpenterworm was the most destructive tree borer in South Dakota. It was also reported as fairly common in South Dakota shelterbelts in 1947 (Severin 1948).

The borings of these insects cause serious tre deformities and low-grade lumber. Attacked tree are structurally weakened and can be broken ov in heavy winds. The holes and tunnels also act a infection courts for wood-destroying fungi.

Scotch Pine

Scotch pine, a fairly abundant ornamenta (Molberg 1954), was observed once in this surve in North Dakota. The tree was without injury and had no apparent insect or disease pests.

Grape

Wild grape plants were observed in four natur al areas during the survey. This plant is mentioned only because it is highly susceptible to damage by 2,4-D, and all plants observed were badly mal formed. The malformations were identical to the condition known as boxelder blight. (See Boxelder section for further discussion.)

Rose

Wild rose bushes were observed in four locali ties. These plants were always growing wild and never were components of shelterbelts. The prairie tent caterpillar (*Malacosoma lutescens*)[16] was ob served feeding heavily on bushes in McHenry County, N. Dak. This insect, like its relatives, is a general feeder and can also defoliate other trees and shrubs over extensive areas.

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[14] *Collected by Paul E. Slabaugh, 1960, Lake States Forest Experiment Station, Bottineau, N. Dak.*

[15] *N. D. Wygant. Borer control experiments in the Great Plains during 1936. Unpublished report (1937) on file at the U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colo.*

[16] *Identified by Frederick W. Stehr, University of Minnesota.*

OTHER CAUSES OF DECADENCE

Lack of sufficient moisture is one of the factors limiting tree and shrub survival in the Plains. The available rainfall and ground water in the eastern part of North Dakota and South Dakota are generally minimal for many of the shelterbelt species. Cottonwood appeared to be the least drought-resistant species observed during the survey. Some 31 shelterbelts had complete or partial losses of cottonwoods. Although these losses were attributed to drought, disease may have been partially responsible for some decadence. Where water was abundant, however, the cottonwood thrived very well.

In one of the belts examined, all the trees were dead; this was thought to be due to insufficient moisture (fig. 11).

The incessant winds that blow across the Plains continually stir the branches of trees and shrubs in the shelterbelts. Most of the species apparently are uninjured by wind. Siberian peashrub, however, which is a species planted on the outer row, had 47 locations with some wind damage to the foliage. Boxelder, too, occasionally showed frayed leaves from continual whipping of the branches. Wind damage was also evident in a few green ash.

F-500794
FIGURE 11. — Shelterbelt deteriorated because of insufficient moisture.

F-500796
FIGURE 12. — Cattle in shelterbelts promote low-vigor trees and shrubs.

Damage from hail was apparent but not serious in several shelterbelts. Small pieces of bark and an occasional small branch were removed, but no trees were killed from hail. Old hail scars were occasionally seen and appeared well healed.

Overmaturity can also be a problem in the Great Plains. Several stands, particularly those occurring naturally, showed general decadence. Since these were usually large trees with no apparent insect or disease problems, the cause of damage was attributed to overmaturity.

Finally, damage from domestic animals is a problem in shelterbelts. Occasionally cattle, sheep, goats and turkeys were observed during the survey (fig. 12). Trees in these belts usually looked unhealthy and showed signs of deterioration. The lower limbs were often browsed, which decreased their efficiency as a wind barrier. The hard, trampled soil certainly contributed to the belt's degradation by reducing soil porosity.

Although not noted during the survey, other causes of decadence can be extensive and destructive to shelterbelts; these include fire damage, snow breakage, soil drifting and sleet and ice damage.

SUMMARY

In 1960, a systematic survey was conducted to obtain information concerning the forest insects and forest diseases presently occurring in the Northern Great Plains region. The larger part of the survey was made in North Dakota and South Dakota in the area where shelterbelts are most concentrated. In all, 325 areas were examined. Of these, 285 were shelterbelts and windbreaks, 30 were naturally wooded areas, 5 were ornamental plantings on farms and in towns, and 5 were nurseries.

More than 80 species of insects were collected and identified from the tree and shrub species examined. Also, several diseases were identified, and cases of damage by unknown causes were occasionally observed.

In spite of the absence of high populations at this time, the mere presence of this large number of potentially serious pests warrants further research, especially along the lines of: (1) methods of detection of population buildups in their early stages, (2) studies of the biology and ecology of those pests approaching damaging population levels, and (3) tests to determine adequate control methods.

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APPENDIX

TABLE 2. — *A list of hosts and injurious agents encountered in the Northern Great Plains survey*

Host	Injurious agent[1]	
Green ash	**Sphinx chersis*	Great ash sphinx
	**Megachile* sp.	Leaf cutting bee
	**Phyllophaga* sp.	White grub
	**Eriophyes fraxiniflora*	Ash flower-gall mite
	Lecanium sp.	Scale insect
	Prociphilus fraxinifolii	Aphid
	Neoborus amoenus	Ash plant bug
	Tethida cordigera	Black-headed ash sawfly
	Phlyctaenia sp. (?)	Leaf skeletonizer
	Contarinia canadensis	Gall midge
	Mycodiplosis cerasifolia	Gall midge
	Epitrix sp.	Flea beetle
	Pareophora sp. (?)	Sawfly
	Chaelophorus sp.	Aphid
	*"Boxelder blight"	2,4-D damage
	Species unknown	Leaf disease
Boxelder	**Proteoteras willingana*	Boxelder twig borer
	**Hyphantria cunea*	Fall webworm
	**Melanoplus* spp.	Grasshoppers
	**Hyalophora cecropia*	Cecropia moth
	**Contarinia negundifolia*	Boxelder gall midge
	**Leptocoris trivittatus*	Boxelder bug
	Species of Tortricidae	Leaf webber
	Species unknown	Gall mite
	Species unknown	Scale insect
	Acronicta americana	American dagger moth
	Acronicta caesarea	An owlet moth
	Chionodes negundella	A gelechiid moth
	Deuteronomos magnarius	Notched-wing geometer
	Species unknown	Scarab beetle
	Species unknown	Leaf hopper
	Species unknown	Gall
	Species unknown	Metallic wood borer
	Lygus sp.	Plant bug
	*"Boxelder blight"	2,4-D damage
American Elm	**Eriosoma americanum*	Woolly elm aphid
	**Colopha ulmicola*	Elm cockscomb gall
	**Cimbex americana*	Elm sawfly
	**Nymphalis antiopa*[2]	Mourning-cloak butterfly
	**Hyphantria cunea*	Fall webworm
	**Melanoplus* spp.	Grasshoppers
	**Corythucha ulmi*	Elm lace bug
	Species unknown	Scale insect
	Species unknown	Leaf beetle
	Conarsia ulmiarrosorella	A phycitid moth
	Heterocampa bilineata	A notodontid moth
	Psorosina hammondi	Apple leaf skeletonizer
	*"Boxelder blight"	2,4-D damage
	Species unknown	Canker
Cottonwood	**Pemphigus populicaulis*	Poplar stem gall aphid
	**Neothomasia populicola*	Aphid

Note: For footnotes, see last page of table.

TABLE 2 (cont'd.)

Host	Injurious agent[1]	
	**Mordwilkoja vagabunda*	Poplar vagabond aphid
	**Hyphantria cunea*	Fall webworm
	**Alsophila pometaria*	Fall cankerworm
	**Chrysomela scripta*	Cottonwood leaf beetle
	Chrysomela crotchi	Aspen leaf beetle
	Acronicta lepusculina	Cottonwood dagger moth
	Nematus ventralis (complex)	Sawfly
	Dicerca tenebrica	Metallic wood borer
Siberian elm	**Hyphantria cunea*	Fall webworm
	Ceratomia amyntor	Elm sphinx
	Empoasca spp.	Leaf hoppers
	Species unknown	Lace bug
	Species unknown	Aphids
	Species unknown	Scale insect
	*"Boxelder blight"	2,4-D damage
	Species unknown[2]	Root rot
Russian-olive	**Estigmene acrea*	Salt-marsh caterpillar
	**Melanoplus* spp.	Grasshoppers
	Species unknown	Weevil
	*Cause unknown	Dieback
	Species unknown	Leaf spot
	Bacterium (?)	Resinosis
	Species unknown[2]	Root rot
Siberian peashrub	**Melanoplus* spp.	Grasshoppers
	**Epicauta subglabra*	Caragana blister beetle
	**Lytta nuttallii*	Nuttall blister beetle
	Macrosiphum caraganae	Caragana aphid
	Phyllotreta sp.	Flea beetle
	Psylla negundinis	Boxelder psyllid
American plum	**Heterocampa manteo*	Variable oak leaf caterpillar
	**Hyphantria cunea*	Fall webworm
	**Melanoplus* spp.	Grasshoppers
	Cyrtophorus verrucosus	Long-horned beetle
	Bucculatrix sp.	Leaf skeletonizer
	Species unknown	Leaf spot
Willow	**Pontania desmodioides*	Gall sawfly
	**Pontania pomum*	Willow apple gall midge
	**Hemileuca nevadensis*[2]	Nevada buck moth
	**Rhabdophaga strobiloides*	Willow cone gall midge
	**Melanoplus* spp.	Grasshoppers
	**Hyphantria cunea*	Fall webworm
	Phytophaga walshii	Gall midge
	*"Boxelder blight"	2,4-D damage
Tatarian honeysuckle	**Melanoplus* spp.	Grasshoppers
	**Lytta* sp.	Blister beetle
	**Hyphantria cunea*	Fall webworm
	**Megachile* sp.	Leaf cutting bee
	Species unknown	Leaf disease
Junipers	**Tetranychus* spp.	Mites
	**Oligonychus* spp.	Mites
	**Gymnosporangium.... juniperi-virginianae*	Cedar-apple rust
Common chokecherry	**Malacosoma lutescens*	Prairie tent caterpillar
	**Hyphantria cunea*	Fall webworm
	**Archips* sp.	Leaf webber
	**Hyalophora cecropia*	Cecropia moth

Note: For footnotes, see last page of table.

TABLE 2 (cont'd.)

Host	Injurious agent[1]	
	**Alsophila pometaria*	Fall cankerworm
	**Aphis cerasifoliae*	Aphid
	**Coccomyces lutescens*	Cherry leaf spot ("Shothole")
	**Dibotryon morbosum*	Black knot of cherry
	*"Boxelder blight"	2,4-D damage
Hackberry	*Species unknown	Hackberry gall
	Pachypsylla vesiculum	Gall psyllid
	Nephopteryx sp. (?)	Leaf skeletonizer
	Species unknown	Scale insect
	**Melanoplus* spp.	Grasshoppers
	Calligrapha sp.	Leaf beetle
Common lilac	**Megachile* sp.	Leaf cutting bee
Ponderosa pine	**Rhyacionia frustrana bushnelli*	Tip moth
	**Ceramica picta*[2]	Zebra caterpillar
	*Damping-off	Several fungi
Blue spruce	No injurious organisms	
Apple	**Sphinx drupiferarum*	Hackberry sphinx
	**Gymnosporangium* sp.	Cedar-apple rust
Bur oak	**Corythucha arcuata*	Oak lace bug
	**Disholcaspis* sp.	Bullet gall wasp
	**Acraspis macrocarpae*	Gall wasp
	**Acraspis villosa*	Gall wasp
	**Andricus ignotus*	Gall wasp
	**Xystoteras poculum*	Gall wasp
	**Philonix nigra*	Gall wasp
	**Adleria dimorpha*	Gall wasp
	Hoplochiatophorus quercicola	Aphid
	Psilocorsis sp.	Leaf webber
	Lecanium sp.	Scale insect
	Caliroa sp.	Sawfly
	Species unknown	Froghopper
Peking cotoneaster	**Datana ministra*	Yellow-necked caterpillar
	*Species unknown	Tortricid moth larva
Silver buffaloberry	**Datana* sp.	Leaf webber
Sand cherry	**Estigmene acrea*	Salt-marsh caterpillar
	**Dibotryon morbosum*	Black knot of cherry
Quaking aspen	*Species unknown	Leaf beetles
	**Saperda calcarata*[2]	Poplar borer
	Species unknown	Aphid
	**Hypoxylon pruinatum*	Hypoxylon canker
White spruce	No injurious organisms	
Honeylocust	**Cameraria* sp.	Leaf miner
Silver maple	**Rhytisma acerinum*[2]	Tar spot
	Cause unknown	Dieback
Pin cherry	No injurious organisms	
Skunkbush sumac	No injurious organisms	
Eastern hophornbeam	No injurious organisms	
Douglas-fir	No injurious organisms	
Paper birch	**Prionoxystus robiniae*[2]	Carpenterworm
Scotch pine	No injurious organisms	
Grape	*"Boxelder blight"	2,4-D damage
Rose	**Malacosoma lutescens*	Prairie tent caterpillar

* Discussed in the text.

[1] Most pests were identified by members of the Insect Idenification and parasite Introduction Section, Agricultural Research Service, Beltsville, Md.

[2] Pests not observed by the author during the survey; information derived from other sources.

TABLE 3. — *Principal hosts and recommended control for the most important injurious agents encountered in the Northern Great Plains*

Injurious agent	Principal hosts[1]	Recommended control
Ash flower-gall mite	Green ash (male trees only)	Seldom needs control. Dormant sprays when numerous.
Boxelder bug	Boxelder and maples	Control usually not necessary. Chlordane when desired.
Boxelder gall midge	Boxelder	Control difficult and seldom warranted.
Boxelder twig borer	Boxelder	Cut and burn infested twigs in late June.
Caragana blister beetle	Siberian peashrub	Malathion when defoliation is noticed.
Cecropia moth	Boxelder, chokecherry	Parasites and diseases are often effective. DDT, June to late September.
Cottonwood leaf beetles	Cottonwood, quaking aspen, and willow	DDT, June.
Elm cockscomb gall	American elm	Natural controls effective. Chemical control impractical and unnecessary.
Elm lace bug	American elm, Siberian elm	DDT, early June to August.
Elm sawfly	American elm, willow	DDT, June to October.
Fall cankerworm	Cottonwood, apple	DDT, May to June.
Fall webworm	Boxelder, cherry	Cut webbed limbs and destroy them.
Grasshoppers	Siberian peashrub	Poison baits, August[2]
Great ash sphinx	Green ash, lilac	Hand pick and destroy the larvae; or DDT, July to September.
Hackberry gall	Hackberry	Control difficult and usually unnecessary.
Hackberry sphinx	Apple, plum, hackberry, cherry	Hand pick and destroy the larvae; or DDT, June to September.
Leaf cutting bee	Green ash, lilac	Control not necessary.
Mourning-cloak butterfly[3]	American elm, willow, and poplars	DDT, May to September
Nevada buck moth[3]	Willow and poplars	DDT, May to August.
Nuttall blister beetle	Siberian peashrub	Malathion when defoliation is noticed.
Oak lace bug	Bur oak	DDT, June to August.
Poplar borer	Quaking aspen	Control difficult. DDT on adults possible from June to August.
Poplar stem gall aphid	Cottonwood, poplars	Parasites and predators effective. Chemical control impractical and difficult.
Poplar vagabond aphid	Cottonwood, poplars	Remove and destroy new and old galls when numerous.
Prairie tent caterpillar	Chokecherry	DDT, June to July.
Salt-marsh caterpillar	Russian-olive, sand cherry	Toxaphene, June to August (DDT is not effective).[4]
Spider mite	Junipers, spruces	Aramite, Ovitran, Kelthane.
Tip moth	Ponderosa pine	Cut and burn infested buds, June to July; or soak tree with DDT.
Variable oak leaf caterpillar	Plum, oaks, basswood	Populations decline naturally. Control seldom recommended.
White grub	Green ash, grasses	Chlordane dust or granules on soil.
Woolly elm aphid	American elm	Malathion, June.
Yellow-necked caterpillar	Cotoneaster	Hand pick and destroy infested twigs. DDT effective when numerous.
Black knot of cherry	Chokecherry, plum	Cut infected stems and destroy.
Boxelder blight	Boxelder, American elm	No known preventive.
Cedar-apple rust	Junipers, apple	Spray junipers or apple trees with fungicides. On junipers, cut galls and destroy.
Damping-off	Ponderosa pine	Varies with host, agent and soil properties.
Hypoxylon canker	Quaking aspen	Control impractical other than removing infected trees.
Russian-olive dieback	Russian-olive	Cause unknown.
Russian-olive root rot[3] [5]	Russian-olive	Control impractical.
Shothole	Chokecherry	Control difficult.
Siberian elm root rot[3] [5]	Siberian elm	Control impractical
Tar spot[3]	Siver maple	Control unnecessary; disease lessened by destroying fallen leaves in fall.

[1] Injurious agent is discussed under first host in each list.

[2] See Wilson (1961).

[3] Agent not observed by the author during the survey; information derived from other sources.

[4] See Brown (1951).

[5] Not discussed in the text but considered an important injurious agent.

SOME RECENT STATION PAPERS

LAKE STATES FOREST EXPERIMENT STATION

Streambank Stabilization in Michigan — A Survey, by W. D. Striffler. Sta. Paper 84, 14 pp., illus. 1960.

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